



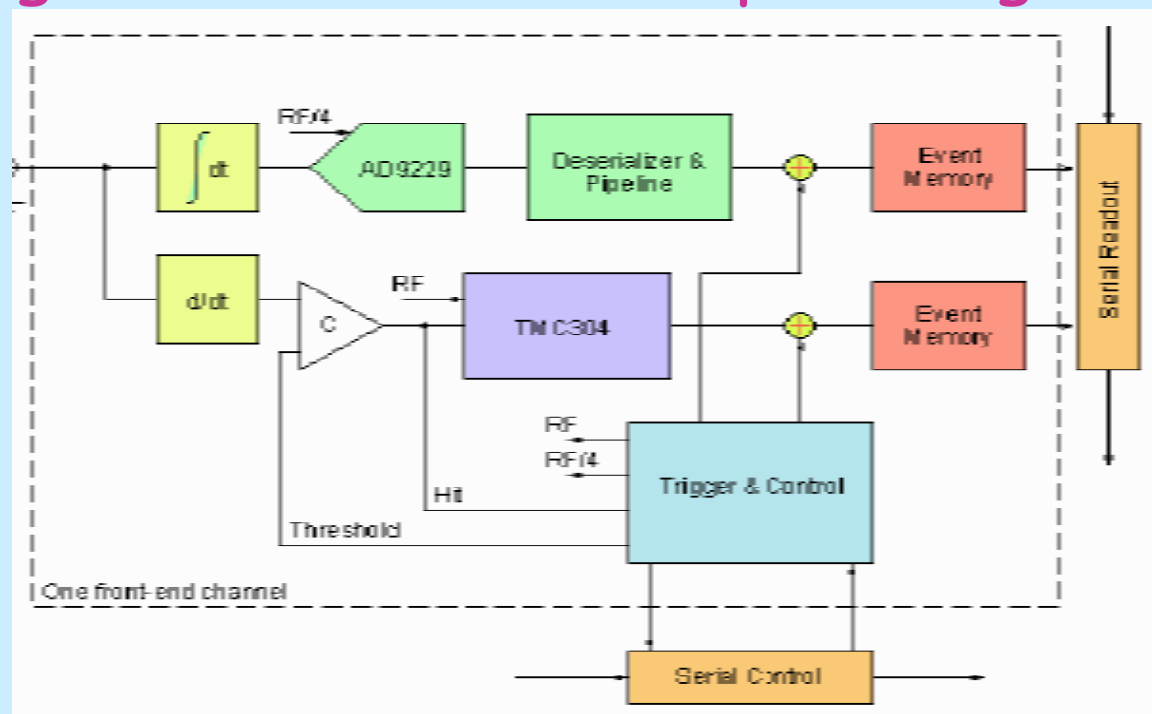
Plastic Ball FE Electronics Testing MIPP Upgrade

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Fermilab

Outline

- Electronics requirements

- Charge measurements with separation of slow ($\sim 1 \mu\text{s}$) and fast ($\sim 10 \text{ ns}$) PMT components
- Dynamic range from .25 to 1000 pC charge
- Trigger
- Memory





PBFE PCB tests

- Use internal pulser to generate 1000 pulses on each of the 8 (0-7) channels
- Set the pulser for DAC setting of 100, 200, 400, 600, and 800 counts
- $1000 \times 8 \times 5 = 40,000$ pulses which are digitized (15 slices per pulse - baseline from ADC(1) and ADC(2)) and TDC timed
- 32392 pulses that are digitized with baseline ADC between 20-70 counts.
- 12605 pulses with good timing (trailing edge-leading edge > 0 and $0 < \Delta < 50$ counts)



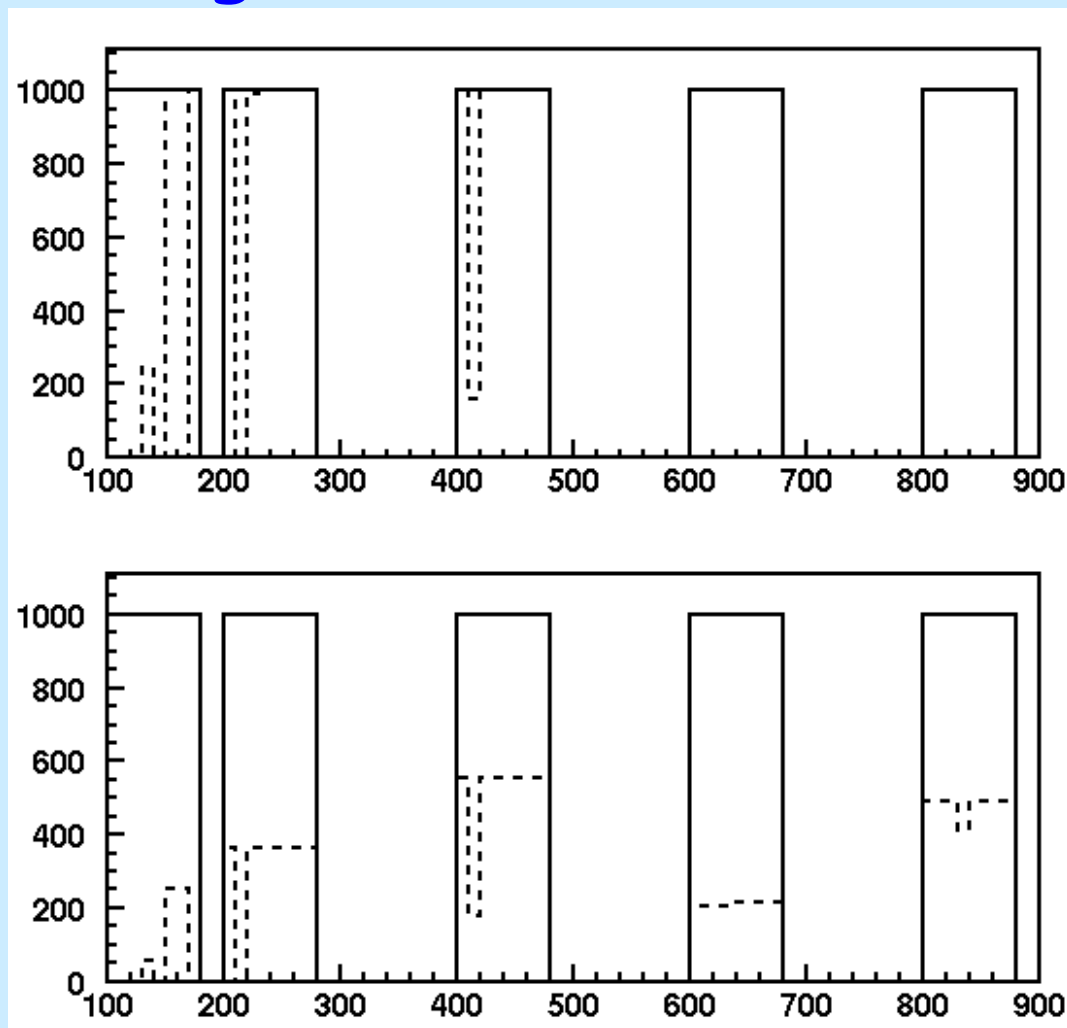
Some global features

- Most of the pulses that are lost (baseline=0) are with the lowest DAC=100 setting. Chan 1 also has some inefficiencies for DAC=100,200,400.
- Sometimes, the contents of the ADC are >500 counts for Chan 1 DAC=100 (757 instances).
- Chan 1 also has a baseline ~80-83 counts for DAC=400 (171 instances total w/98 bad timing).
- Timing is missing on most of the pulses especially for DAC=100, but across all channels.
- 3 pulses have timing recorded but the leading edge is at later time than the trailing edge.



"Good" pulses and timings vs DAC and chan

- Look at DAC setting + 10 x channel
- Top plot shows pulses with good digitization.
- Bottom plot shows pulses with good timing.





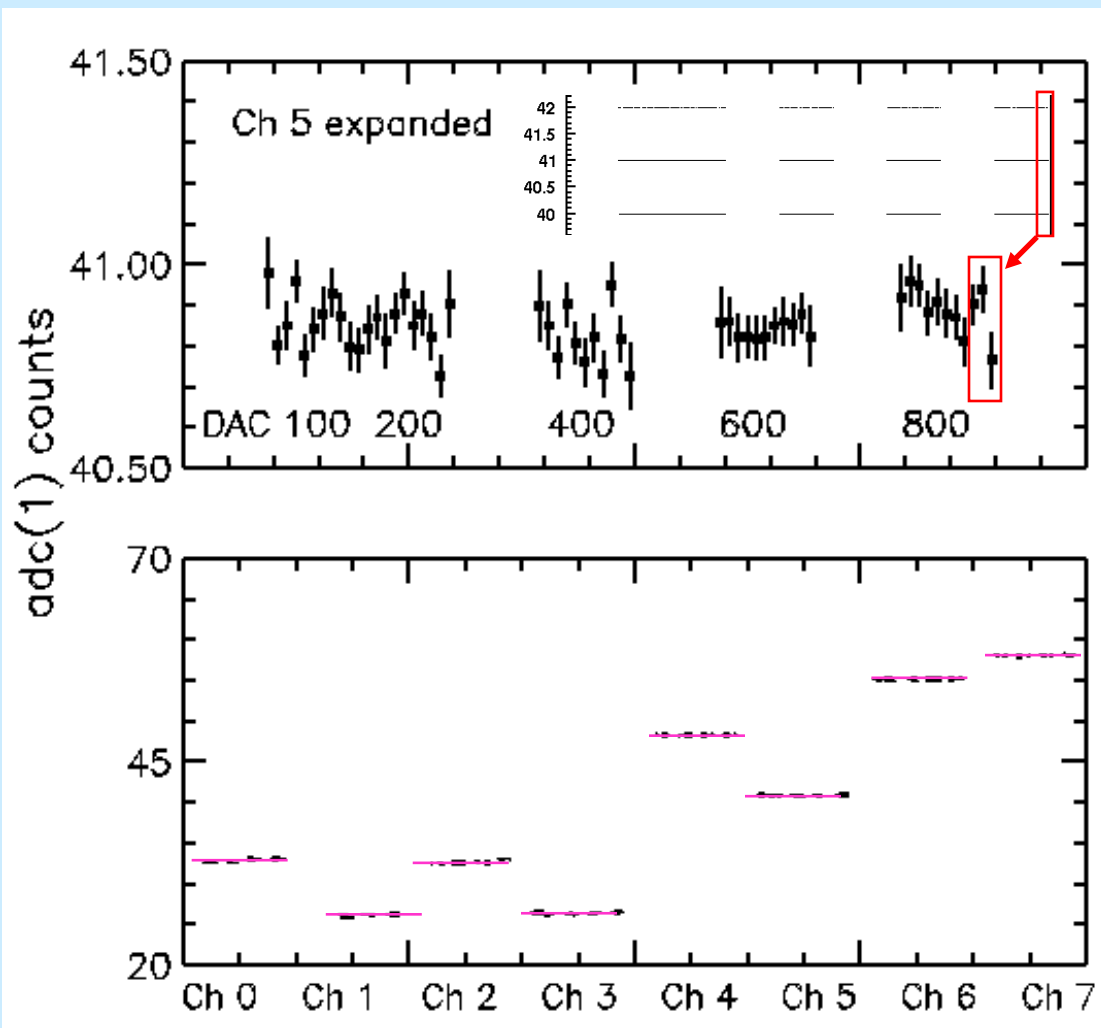
Focus on good pulses

- Define some pulse quantities
 - Baseline = $\frac{1}{2} \times [\text{adc}(1) + \text{adc}(2)]$. This varies from channel to channel from 26-58 counts.
 - Qsum = sum from $i=1$ to 15 of $\text{adc}(i)$
 - Qbavg = sum from $i=1$ to 15 of $\text{adc}(i)$ - 15 x the average baseline for that channel.
 - Qbavg311 = sum from $i=3$ to 11 of $\text{adc}(i)$ - 8 x the average baseline.
- Timing quantities
 - Leading and trailing edges are digitized

Baseline variation

- Look in detail at the variation of ADC bin 1

The top plot shows some detail for channel 5 – it is an expanded view of the bottom plot. Here you can see `adc(1)` for the different DAC settings. The 1000 events for each DAC setting are divided up as a function of acquisition to see if there is a drift vs time. The red box on the top shows the last bit of data recorded with DAC=800 where `adc(1)` varies between 40, 41, and 42 counts. The bottom plot shows all the channels and thus the chan-to-chan variation.



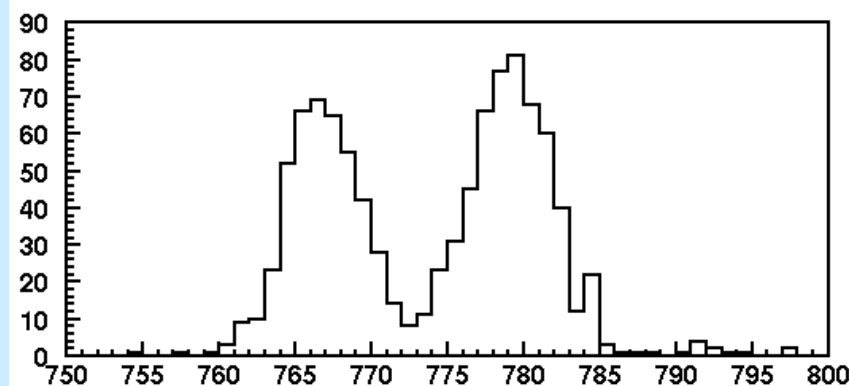


Use average baseline

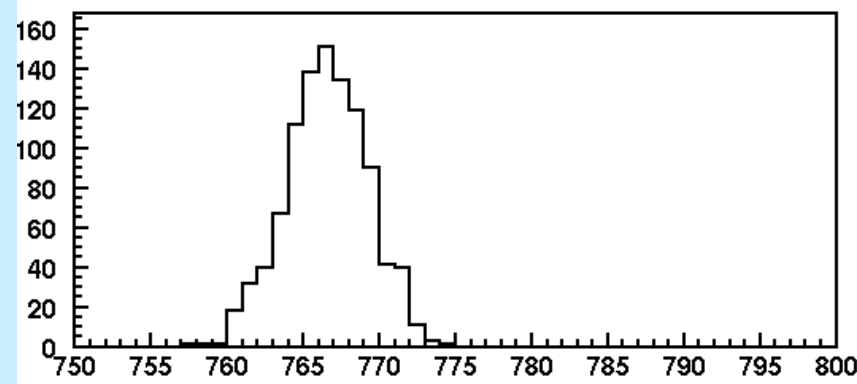
- The baseline fluctuates event-by-event by about \pm a count. This adds up if you use it to subtract all 15 ADC slices.

Channel 6 with DAC=800

Top plot: Qsum minus
15 x baseline
(which varies event-by-event)



Bottom plot: Qsum minus
15 x average
baseline
(averaged over all events for the channel,
and less susceptible to fluctuations.)

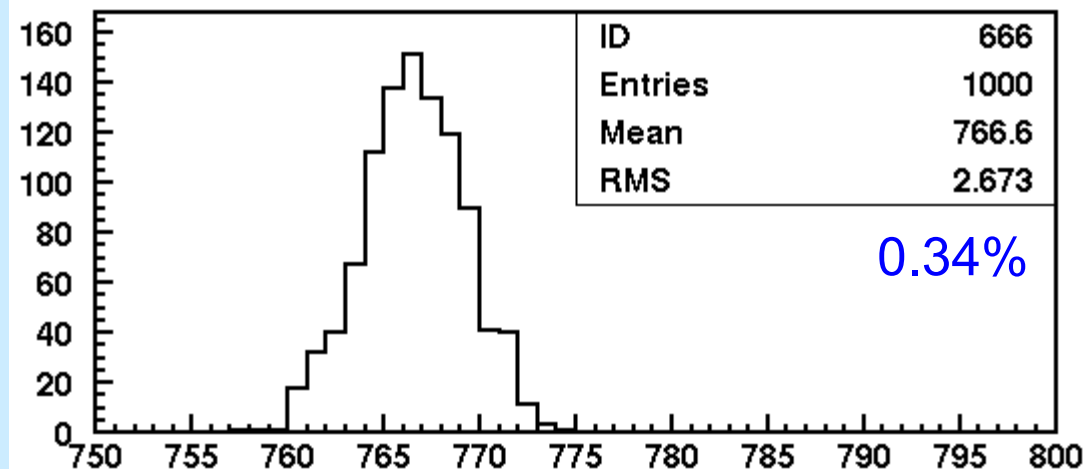




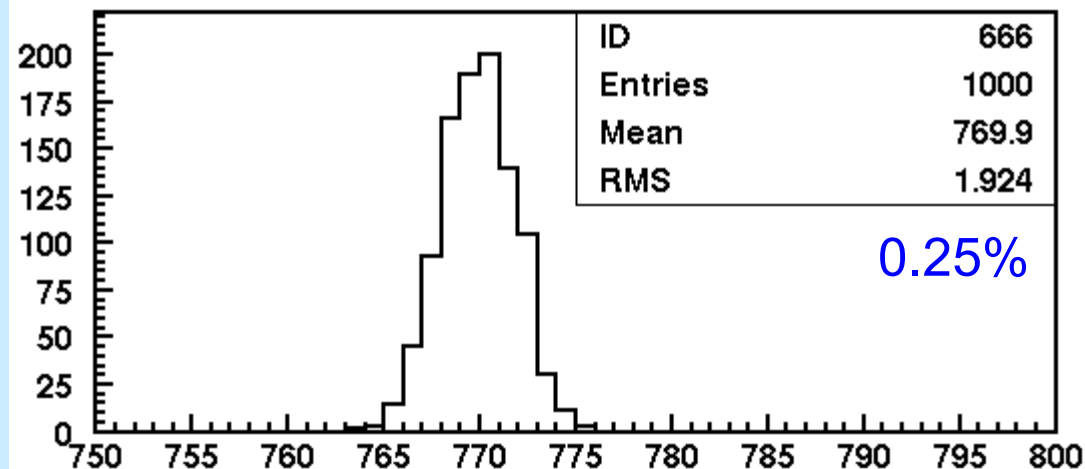
Better resolution using $\text{adc}(i)$ for $i = 3$ to 11

Channel 6 with DAC=800

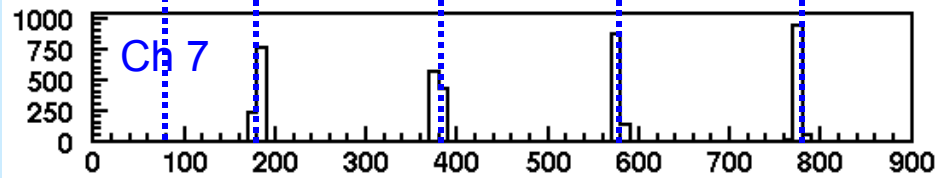
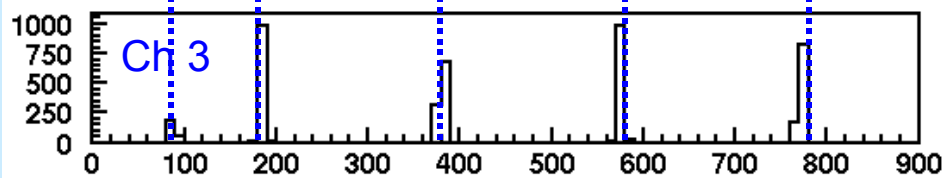
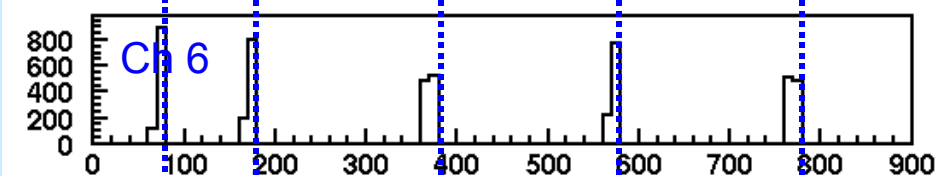
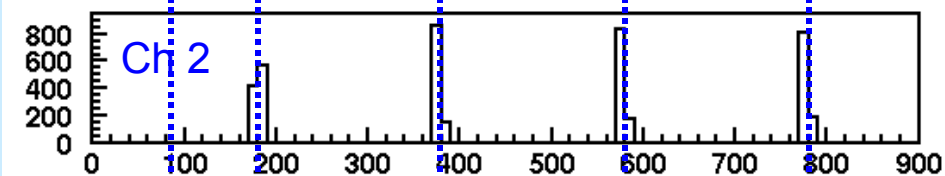
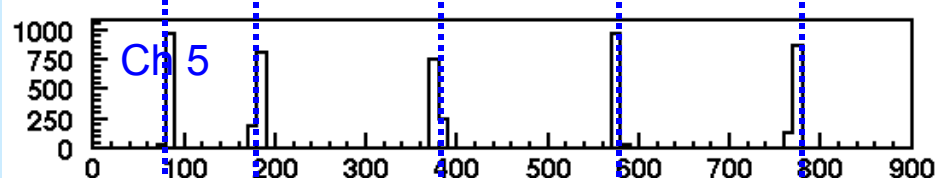
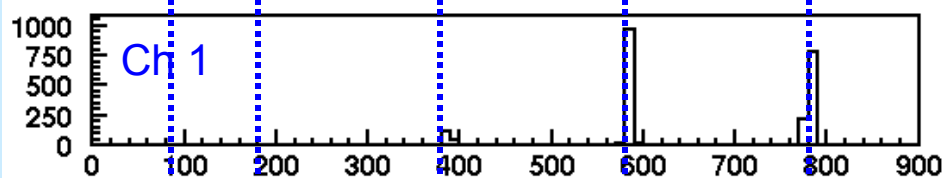
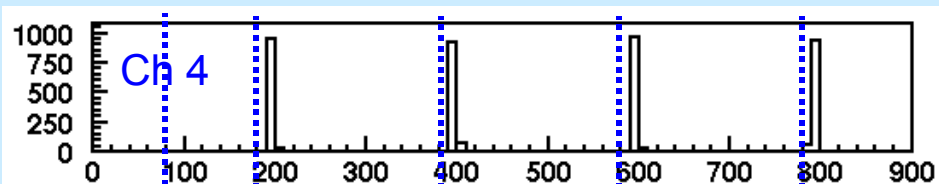
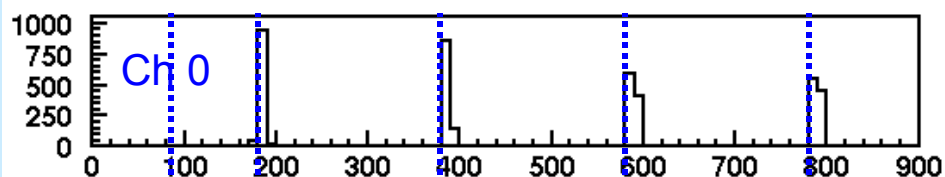
Top plot: Qsum minus
15 x average
baseline



Bottom plot: Qsum from
 $\text{adc}(3)$ to $\text{adc}(11)$
minus 8 x average
baseline

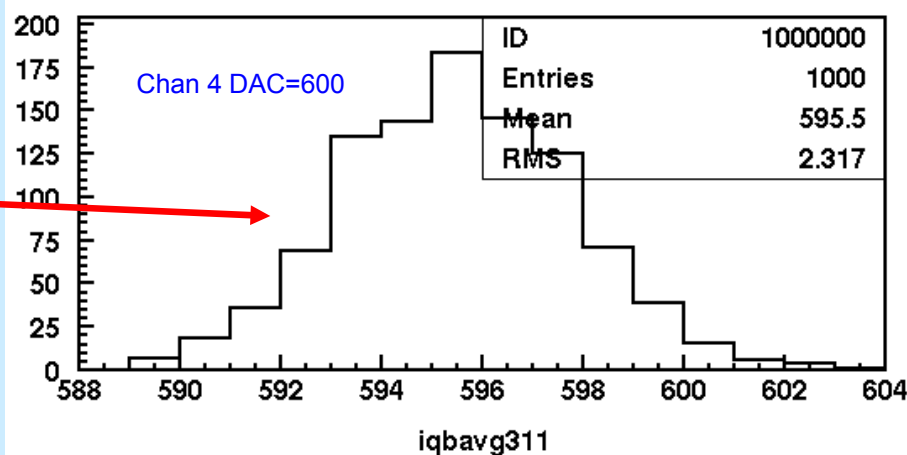
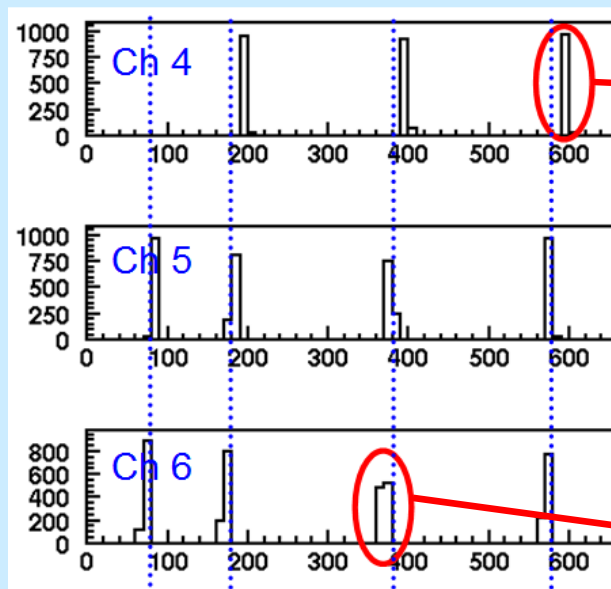


- Look at the channel response to the five different DAC settings.

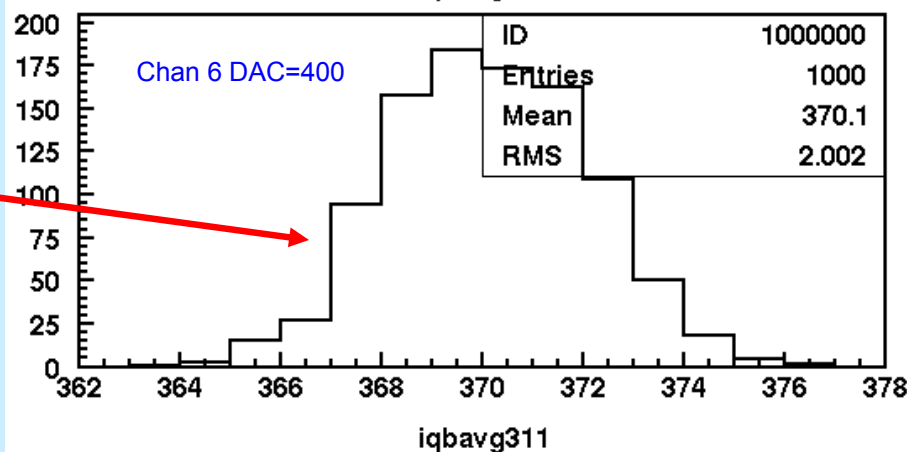


Resolution on a channel

- Use Chan 4 DAC=600 and Chan 6 DAC=400 (increased width was just a histogram binning effect).



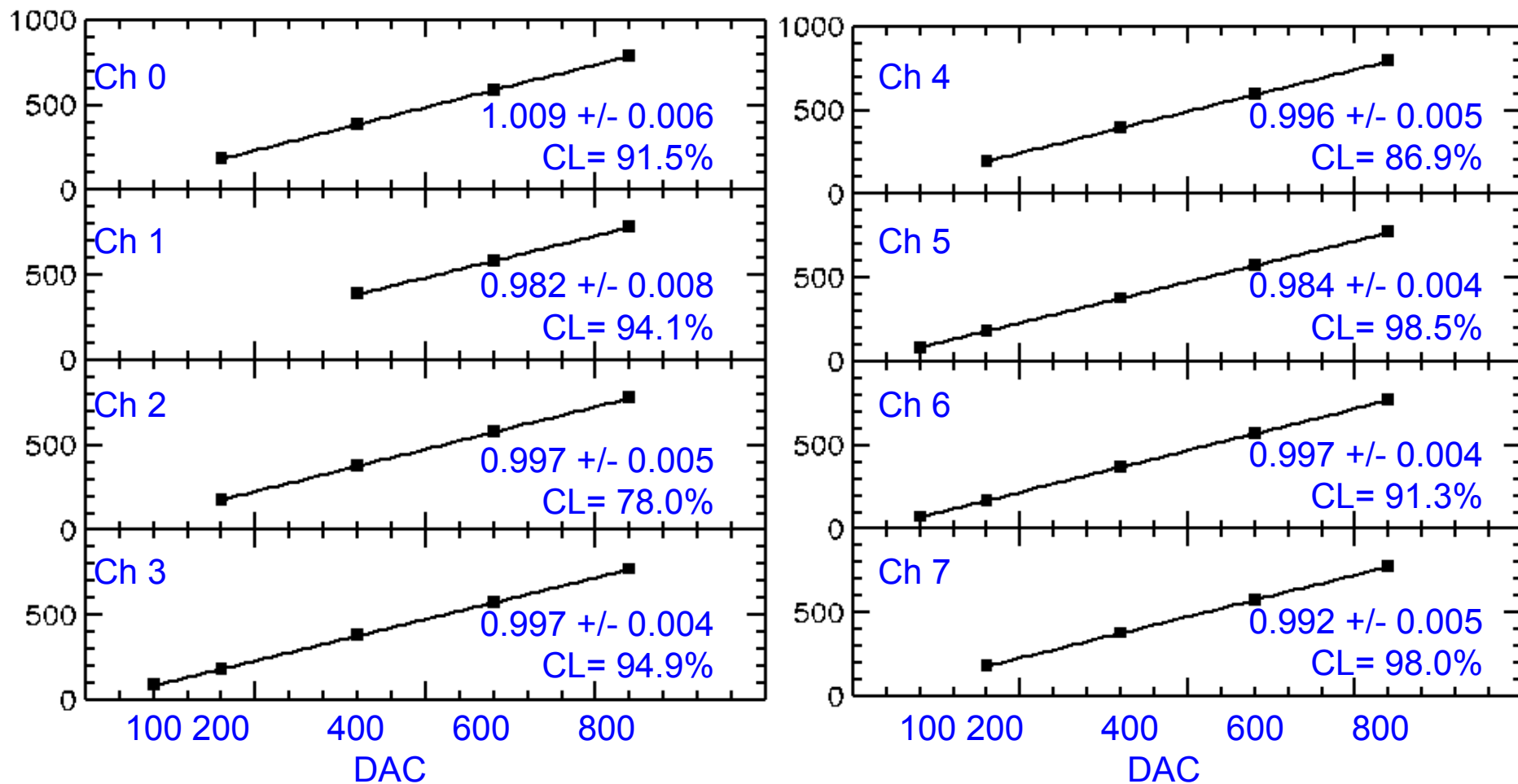
0.4%



0.5%

Linearity

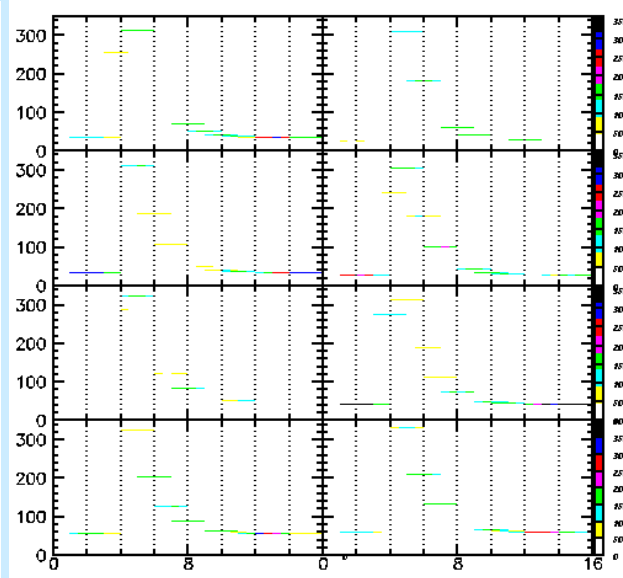
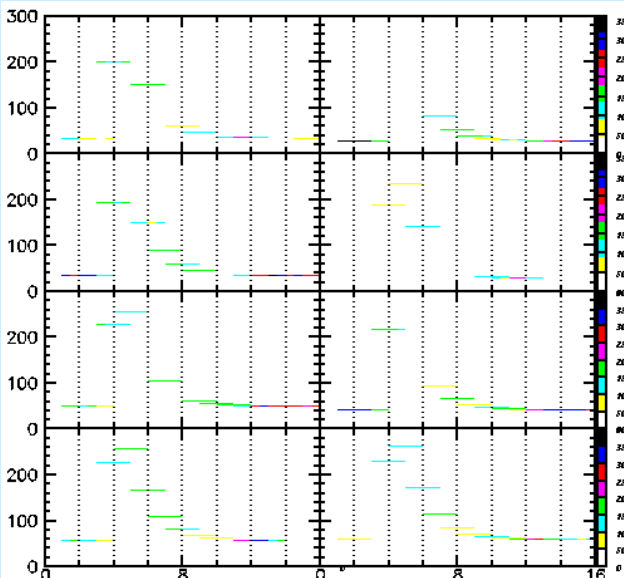
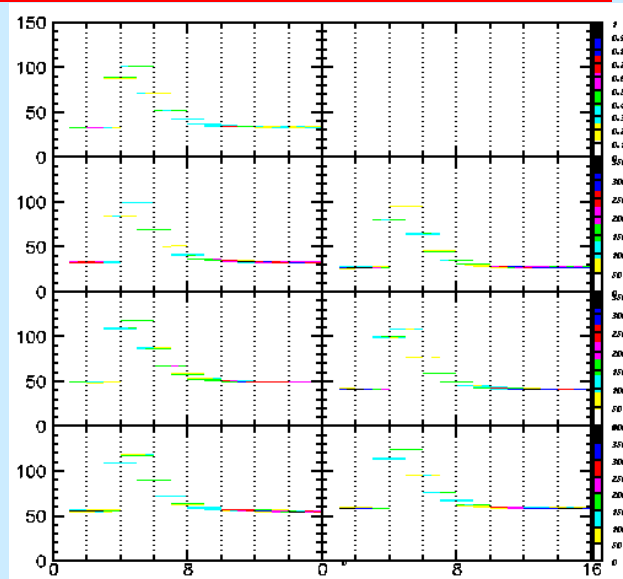
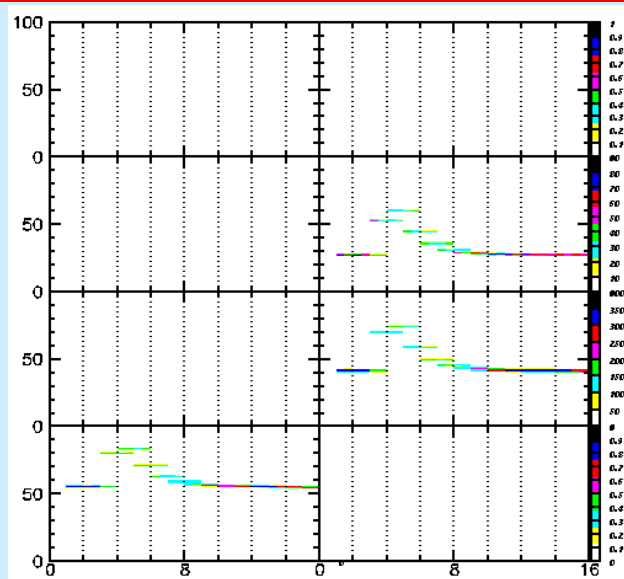
- Mean of Qbavg311 vs DAC setting vs chan





Digitized pulse shape (1)

Look at each of the
5 DAC settings and
then the 8 channels.
the color scale shows
how often each of the
ADC bins has a given
value (see next slide).
(spread out the 1000 evts)

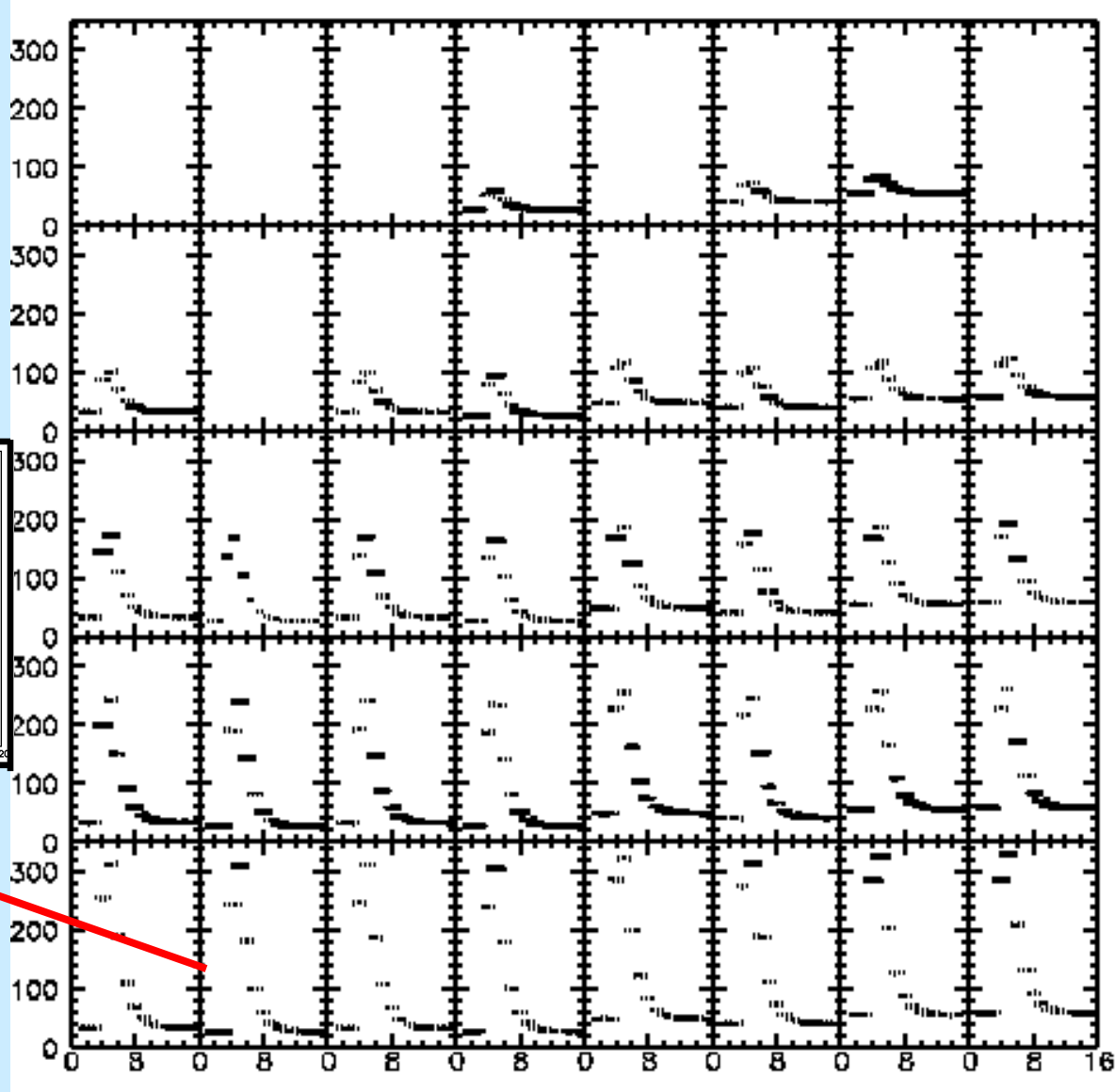
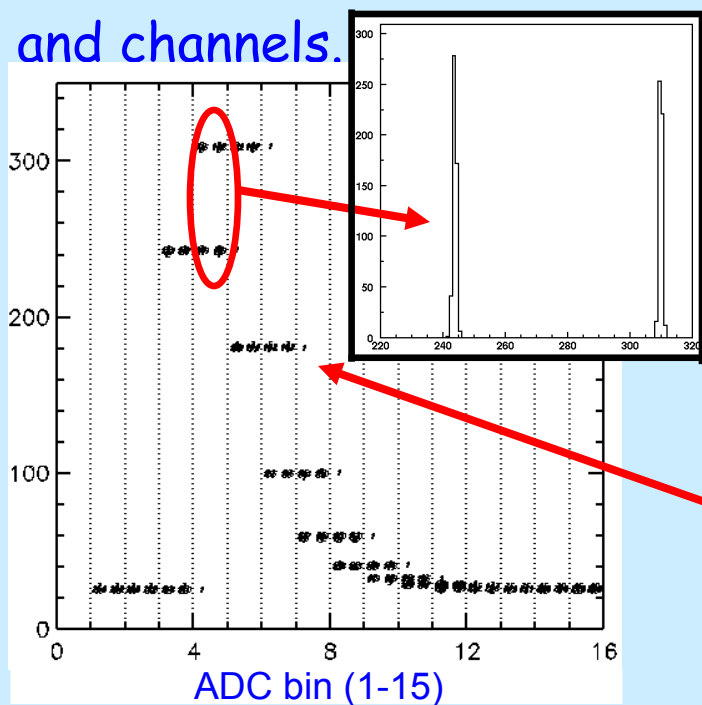


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Digitized pulse shape (2)

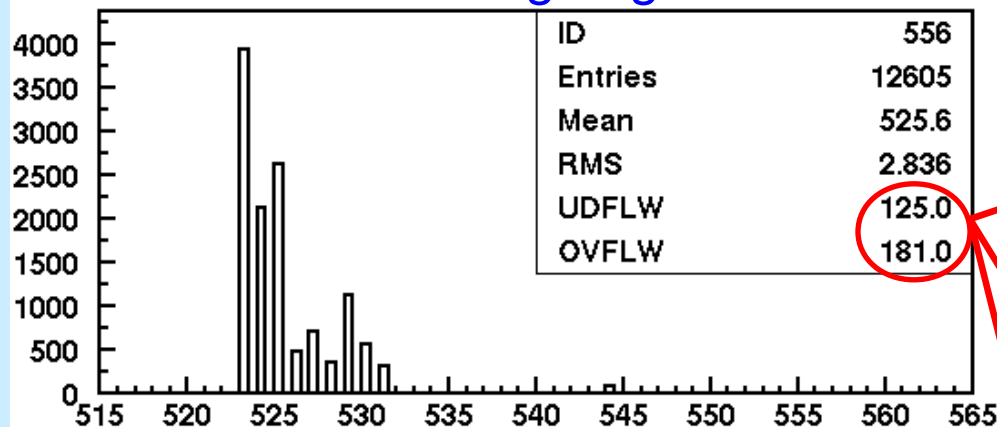
Same information, with each row a DAC setting and each column a channel. ADC bins seem to be digitized near discrete ranges depending on DAC and channels.



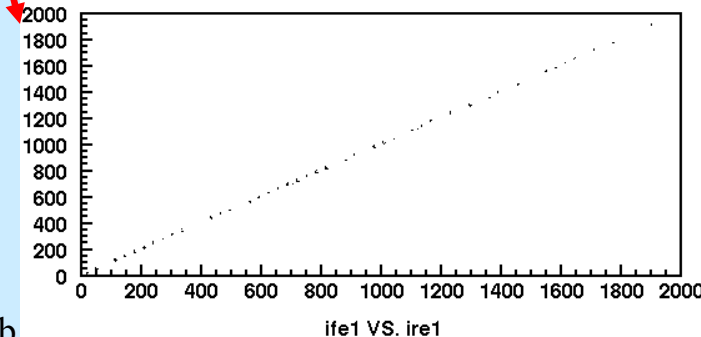
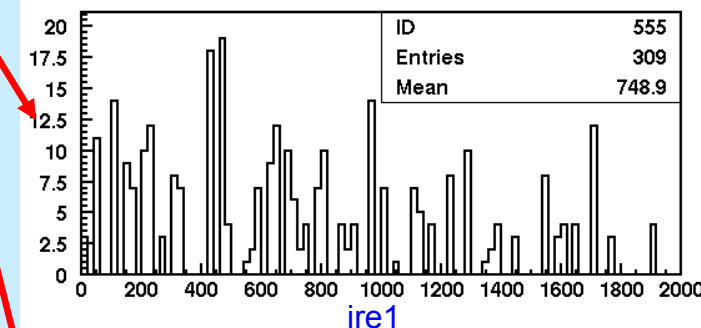
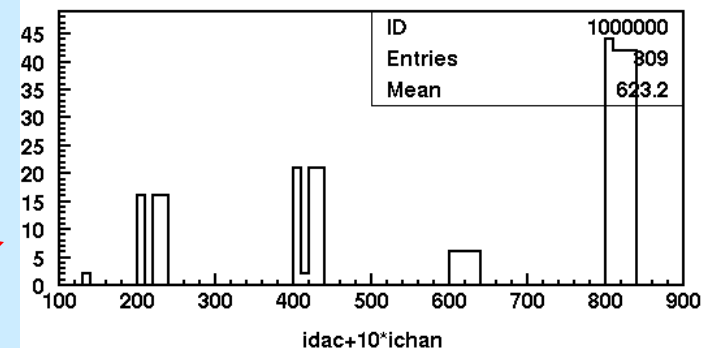
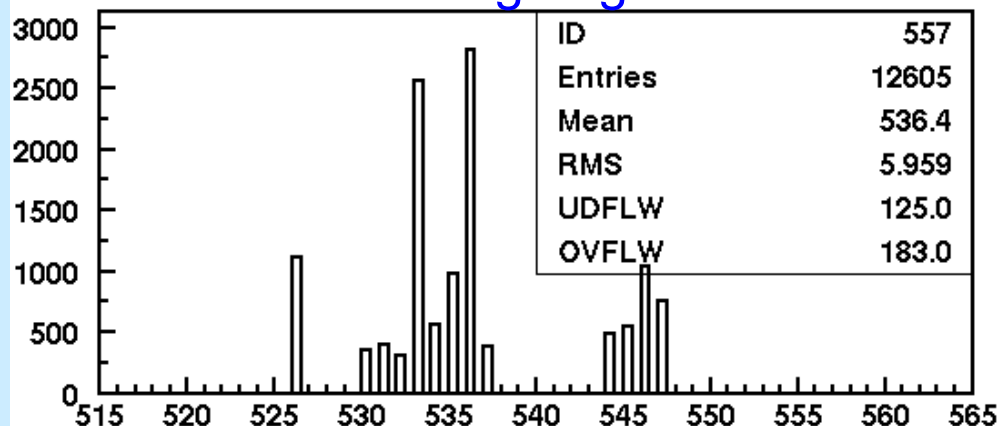
Timing

- 12605 good pulses with good timing

Leading edge

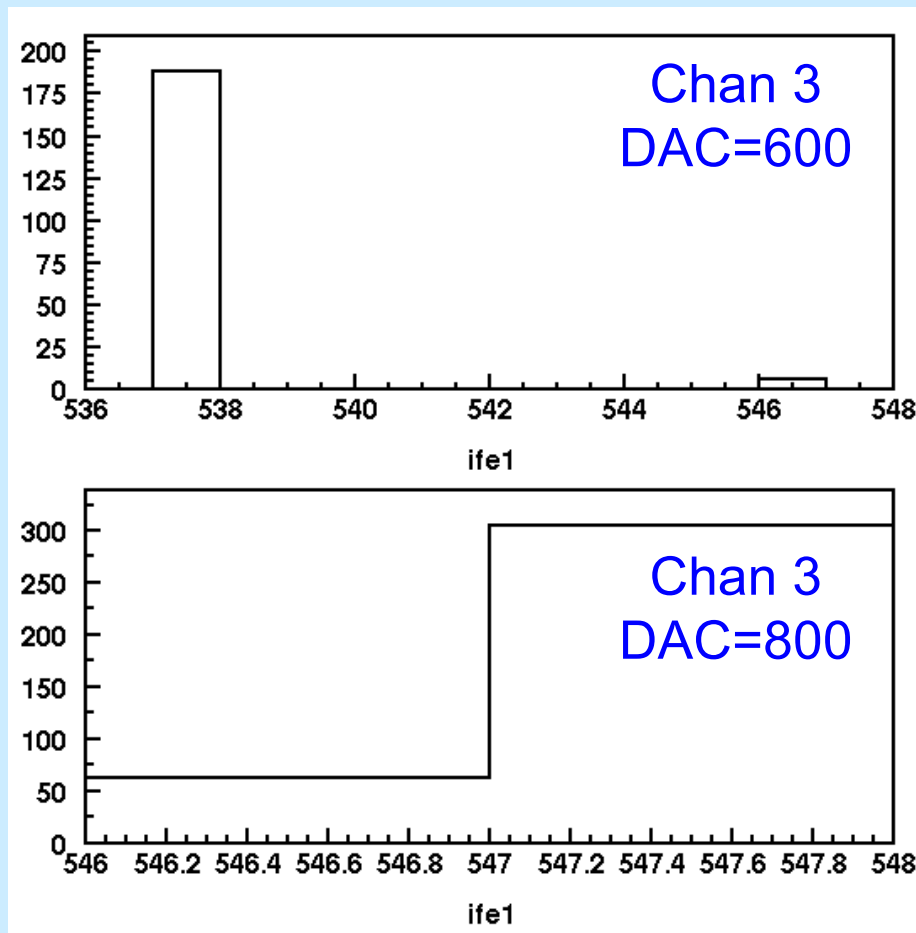


Trailing edge



Timing

- Near single count resolution for each DAC/channel
- Variation of 1 or 2 counts except chan 3 DAC=600



Time difference

- 12605 good pulses with good timing

